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THE CLEVELAND SURVEY TESTS IN ARITHMETIC IN THE MIAMI VALLEY

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During February, 1917, the arithmetic tests used in the Cleveland Survey were given in a number of the smaller cities and villages and also in a considerable number of the rural schools of the Miami Valley in southwestern Ohio. To be more specific, there were represented seven city and village systems and all the rural schools of one county and those of one of the several supervision districts of another county. The purpose in giving the tests was to find out the quality of work done along abstract lines (1) in the several systems individually, (2) in all the city and village schools as compared with all the one-room rural schools, and (3) in the city, village, and rural schools as compared with the Cleveland schools. The tests were given under the direction of Professor W. S. Guiler, of the Teachers' College of Miami University, and the papers were scored and the results compiled by the graduating class of that institution. About three thousand papers were obtained, quite evenly divided between town and rural schools. The reason why there was not a larger number of papers from the town schools is that the tests were given to representative schools in the larger places only. It was found impossible on account of limitations of time and labor to give them to all the schools of these systems.

The results obtained are indicated in Table I. The first score in each set is the median for the Cleveland schools. The second is the score of the city and village schools, and the third that of the rural schools participating in this survey.

Set A.—The children of the city and village schools have made a good start in simple addition in the fourth grade. There is considerable improvement up to the eighth grade, however, and the rate of progress is quite consistent, which is contrary to the findings in Cleveland. Village and city schools make as good a score in the

TABLE I

		Grades				
		4	5	6	7	8
Set A: Addition of one-place numbers	1	17.8	22.5	24.8	26.7	27.5
	2	17.8	21.3	23.4	26.6	29.2
	3	......	19.8	23.3	25.1	29.8
Set B: Subtraction of one-place numbers	1	13.4	17.2	19.8	21.5	26.0
	2	10.6	14.5	16.0	18.9	21.0
	3	......	13.5	13.9	19.3	22.9
Set C: Multiplication of one-place numbers	1	12.0	15.5	16.6	17.7	19.0
	2	10.5	12.2	14.6	16.8	16.9
	3	......	12.7	16.2	17.8	19.3
Set D: Division of one- or two-place numbers by one-place numbers	1	12.4	15.7	18.5	20.8	22.5
	2	......	12.3	14.5	17.3	18.9
	3	9.2	12.9	15.8	17.3	22.4
Set E: Addition of single columns of five figures	1	5.3	6.3	6.8	7.5	7.8
	2	3.8	4.9	5.0	5.8	6.1
	3	......	4.1	4.8	5.4	6.7
Set F: Subtraction of three-place numbers from three- and four-place numbers	1	4.9	6.7	7.5	8.6	10.1
	2	3.4	5.1	6.1	7.3	8.0
	3	......	4.7	6.8	7.1	9.9
Set G: Multiplication of four-place numbers by one-place numbers	1	3.9	5.2	5.5	5.9	6.6
	2	2.9	3.8	4.4	5.8	5.9
	3	......	3.8	5.0	5.2	6.3
Set H: Addition and subtraction of fractions with common denominator.........	1	0.0	5.0	5.5	7.7	8.5
	2	0.0	2.7	2.9	3.8	4.8
	3	......	2.5	5.8	6.4	8.3
Set I: Division of five-place numbers by one-place numbers	1	1.1	2.0	3.1	4.0	4.7
	2	0.6	0.9	1.7	2.7	3.8
	3	......	1.1	2.1	2.9	3.8
Set J: Addition of single columns of 13 figures	1	3.2	4.0	4.4	4.9	5.7
	2	2.0	2.0	3.4	3.8	4.6
	3	......	2.5	3.2	3.8	4.6
Set K: Division of two- and three-place numbers by two-place numbers	1	4.0	6.8	8.5	10.1	12.5
	2	1.7	2.5	4.1	6.3	7.7
	3	......	3.1	5.1	6.9	9.5
Set L: Multiplication of four-place numbers by two-place numbers	1	1.7	2.5	2.8	3.2	3.9
	2	1.0	1.8	3.4	3.2	3.8
	3	......	0.9	1.6	2.9	4.1
Set M: Column addition of 5 four-place numbers	1	2.5	3.2	3.8	4.4	5.1
	2	1.6	2.4	3.2	3.6	4.3
	3	......	2.4	3.3	2.4	4.4
Set N: Division of five-place numbers by two-place numbers	1	0.8	1.3	1.7	2.0	2.6
	2	0.5	0.6	0.0	1.3	1.6
	3	......	0.8	0.8	1.1	1.7
Set O: Addition, subtraction, multiplication, and division of fractions	1	0.0	0.0	3.1	4.1	5.5
	2	0.0	1.8	2.5	2.9	3.4
	3	......	0.7	2.6	3.0	3.8

fourth grade, and both city and rural schools excel the Cleveland score in the eighth grade.

Set B.—Pupils do not do so well as in simple addition. The score throughout the grades is lower than in Cleveland. Apparently subtraction is more poorly taught than in Cleveland because in Set F, too, the schools in the Miami Valley are doing rather poorly as compared with those of Cleveland. Individual schools, however, excel the median for Cleveland in certain grades. No such marked superiority of eighth-grade over seventh-grade pupils was found as in Cleveland except in case of Set F, where the eighth grades of the rural schools excel the score of the seventh grades by 2.8 points, the greatest increase along the line.

Set C.—Both village, city, and rural schools make unsatisfactory scores; they also fall below the Cleveland median except in the case of the seventh and eighth grades of the rural schools, which slightly excel the Cleveland schools. On the whole the rural schools did decidedly better than the city and village schools taken as a group. One of the village schools, however, exceeds the record of all rural schools by 0.5 point. The rate of improvement for Grades 6 to 8—Grade 8 of the city systems excepted—in both types of schools is greater in this set than in the Cleveland schools.

Set D.—Here again village and city schools make a rather poor showing in the fourth grade, 9.2 as compared with 12.4 of the Cleveland schools. This is brought about largely, as in the preceding tests, by the poor showing of one of the systems in which the median for this grade is 5. The rural schools too make a rather mediocre showing as compared with the Cleveland score, 12.9 against 15.7 (fifth grade). The gain from grade to grade is but slight until the eighth grade is reached. In this grade the rural schools exceed their seventh-grade score by 5.1 points, almost equaling the Cleveland standard. Village and city schools do not reach the final score which one had a right to expect from the performances of the earlier grades. This is due to the low scores of two of the systems (4 and 6) in the eighth grade.

Set E.—The results in this test are disappointing from the point of view of schools taken both individually and jointly. Judd points out that the Cleveland scores are relatively higher for this column-addition test than for the simple-addition test, Set A. This is not true for the schools included in this survey. In practically every instance the score is below both the Cleveland standard and the record made in Set A. Evidently too little emphasis is placed upon column addition and too much upon simple addition in the schools measured; for while they ranked below the Cleveland scores in Set E they ranked above them in Set A. This is especially true of individual schools.

Set F.—The scores are again somewhat below the Cleveland standard although the eighth grade of the rural schools is only 0.2 point below the Cleveland median. There is no decided increase from the seventh- to the eighth-grade median except in case of the rural schools. The rate of increase from the fourth to the eighth grade in city and village schools varies from 0.7 to 1.7 points, the average being 1.15. The eighth-grade score is 0.7 point above that of the seventh grade, less than the average increase of all grades. In the case of rural schools, however, we find the sharp increase in the eighth-grade score over that of the seventh grade; but there is a similar increase in the case of the sixth-grade score over that of the fifth. It would seem from these data that a sharp increase in the eighth-grade score over the seventh-grade score due to greater maturity of pupils as asserted by Judd is not general.

Set G.—If we leave the eighth grade out of consideration there is a fairly consistent improvement from grade to grade in city and village schools. The rate of improvement is considerably greater in Grades 6 and 7 of city and village schools than in the same grades of the Cleveland schools, while in the rural schools the sixth and eighth grades excel the corresponding grades of the Cleveland system. The fifth grade of the city schools attains a score of 0.9 point above that of the fourth grade; the sixth grade makes twice as great an improvement over the fifth grade as in the Cleveland schools; the seventh grade here makes the greatest of all gains, 1.4 points, three times that of the Cleveland schools. The eighth grade makes the least improvement. In the rural schools there is a very decided improvement in the sixth and eighth grades, but only a very slight one in the seventh. Furthermore, with the exception of the sixth grade, the rate of progress from grade to grade of city and village schools in Set G is fairly consistent with that of

Set C, as may be shown by a comparison of gains made by both the city and the village schools in the two sets. For rural schools this is not the case. The gains are shown in Table II. As far as results in this test go there is but slight indication that the rate of progress with this complex form of multiplication closely correlates with the maturity of the pupils tested. In general, no doubt, this is true, but in this particular test it is questionable whether the greater maturity of the pupils is the cause of the comparatively high score made in the Cleveland schools.

TABLE II

Set	Grades 5	6	7	8
	City and Village Schools			
C........	1.7	2.4	2.2	0.1
G........	0.9	0.6	1.4	0.1
	Rural Schools			
C........	....	3.5	1.6	1.5
G........	....	1.2	0.2	1.1

Set H.—Judging by the returns from this test the teaching of fractions appears to be but poorly accomplished in some of the systems tested. City and village schools as a whole made a poorer score than either the rural schools or Cleveland. Both at the start and in the final grade do the city and village schools measured fall behind the Cleveland standard, more so than in any other test of the series except K, long division. More surprising still is the fact that certain systems make their highest scores in the fifth and eighth grades, the scores in Grades 6 and 7 being lower than those of the fifth grade. Evidently some changes in the courses of study or in their administration are needed to overcome this difficulty. Apparently no real effort is made to apply the knowledge of fractions which children have gained in the fifth grade during the following two years of school. While the rural schools are decidedly below the Cleveland score in the fifth grade they make a very creditable showing in the later grades, excelling Cleveland in the sixth grade and almost equaling the Cleveland median in the eighth grade.

Sets I, K, N (division).—The form of progress of the schools measured differs materially from that of the Cleveland schools in each of these tests, as may be seen from Table III. This table should be read as follows: In Cleveland the fifth grade made a gain of 82 per cent upon the score of the fourth grade in Set I, while the corresponding grade in the city and village schools measured shows an increase of only 50 per cent. From this table it will be seen that in city and village schools progress in the sixth and seventh grades is decidedly greater than in the corresponding grades in Cleveland except in the case of Set N. In this test the sixth grade fails to score. The gain of the eighth grade over the seventh grade is greater than in Cleveland in Set I, but somewhat less in Sets K and N. In case of the rural schools we have the greatest gain in the sixth grade, the first grade where gain can be measured, in Sets I and K, but no increase in Set N. The gain of the seventh and eighth grades in Sets I and K is decidedly less than in the sixth grade, corresponding to the Cleveland rate of progress, while in Set N there is a very positive increase for the last two grades which is contrary to the Cleveland score. It is inconceivable that the very poor showing in Set N is due entirely to the complexity of the exercise. It is more likely to be due to the fact that teachers fail

TABLE III

RATE OF PROGRESS IN SETS I, K, AND N COMPARED

School	Division Tests	Grades 5	6	7	8
Cleveland	I	0.82	0.55	0.29	0.17
	K	0.70	0.25	0.18	0.23
	N	0.62	0.30	0.17	0.30
City and village	I	0.50	0.88	0.58	0.40
	K	0.47	0.64	0.53	0.22
	N	0.20	....	1.16	0.23
Rural	I	....	0.90	0.38	0.31
	K	....	0.64	0.35	0.37
	N	....	....	0.37	0.54

to see the importance of teaching children rapid methods of determining a quotient by the use of an approximate trial divisor. To divide 36,084 by 97 is practically no more difficult than to divide the same number by 17, provided the pupil has been taught to use 100 as the approximate divisor instead of 97. In so far as there is any difference this is due to the greater difficulty of multiplying by 9 rather than by 1.

Sets E, J, M (addition).—The schools measured fall below the Cleveland standard in all three of these tests, most of all in Set E, and least in Set M. The rate of progress in city schools decreases, although not regularly, in Sets E and M from the fifth to the eighth grade, and is erratic in Set J, in which the sixth grade makes an exceptional gain. In case of the rural schools there is an increase from the sixth to the eighth grade in Sets E, J, and M. The unusual element in these tests is the unsatisfactory work of the seventh grade, in Set M especially. Closer supervision of this part of the work and possible changes in the courses of study suggest themselves as means to overcome these unsatisfactory conditions. Table IV shows the rate of progress from grade to grade in these three tests. It should be read: Grade 5 of the city and village schools makes a gain of 28 per cent upon the score of the fourth grade, etc.

TABLE IV

RATE OF PROGRESS IN SETS E, J, AND M COMPARED

School	Column-Addition Tests	Grades			
		5	6	7	8
Cleveland	E	0.18	0.08	0.10	0.04
	J	0.25	0.10	0.11	0.16
	M	0.28	0.18	0.16	0.18
City and village	E	0.28	0.02	0.16	0.05
	J	....	0.70	0.11	0.21
	M	0.50	0.33	0.13	0.19
Rural	E	....	0.17	0.12	0.24
	J	....	0.28	0.18	0.21
	M	....	0.29	−0.27	0.83

Set O.—Some of the schools measured do not study fractions in any serious way until the sixth grade is reached, while others begin in the fifth grade. This accounts for the low scores of both city and rural schools in the earlier grades. It does not justify the poor progress in the later grades and the comparatively low final attainment of both classes of schools. While the scores for both classes of schools indicate fairly consistent progress, individual schools vary considerably from the general tendency. Thus one system making a score of 3.1 in the fifth grade never again rises above 2.5. Apparently fractions are "finished" in the fifth grade and never again studied in any systematic way. Reorganization of the course in arithmetic should make for more uniform and greater progress in this system.

VARIABILITY OF CHILDREN AND SCHOOLS

WHAT DOES GRADUATION FROM THE RURAL SCHOOL SIGNIFY?

VARIABILITY AMONG CHILDREN

Assuming that the lowest 10 per cent of pupils will fail to complete their work in the eighth grade, it means that a graduate from this grade can write the answers between the limits indicated in Table V.

TABLE V

Set	A	from	21	to	54
“	B	“	15	“	40
“	C	“	13	“	45
“	D	“	15	“	38
“	E	“	5	“	19
“	F	“	5	“	19
“	G	“	3	“	13
“	H	“	3	“	24
Set	I	from	1	to	8
“	J	“	1	“	10
“	K	“	3	“	18
“	L	“	1	“	9
“	M	“	1	“	11
“	N	“	0	“	6
“	O	“	0	“	12

In city and village schools pupils in the eighth grade—omitting the lowest 10 per cent—vary as shown in Table VI.

TABLE VI

Set	A	from	21	to	55
“	B	“	13	“	50
“	C	“	11	“	32
“	D	“	12	“	38
“	E	“	3	“	12
“	F	“	5	“	16
“	G	“	3	“	13
“	H	“	0	“	15
Set	I	from	1	to	9
“	J	“	2	“	10
“	K	“	1	“	9
“	L	“	1	“	24
“	M	“	1	“	9
“	N	“	0	“	5
“	O	“	0	“	10

Unless 10 per cent of the children fail to be promoted, the variability is considerably greater, the lower limit extending to zero in every test except D for the rural schools, and D, F, and G in city and rural schools.

VARIABILITY AMONG SCHOOLS

Not only is there considerable variability among *pupils* taking the test, but the same is true of *schools*. In the case of city and village schools the scores attained vary, as may be seen in Table VII.

The rate of progress from grade to grade is very uncertain. Thus System IV, while uniformly low in the fourth-grade scores owing to the influx of foreign children at this point, makes very decided progress from the fourth to the fifth grade. But from this point progress is often very slow, and in at least one test (H) the fifth-grade score in this system is the highest attained by any grade. The score in Set E of the fourth grade in System VIII is 0.1 of a point higher than that of the seventh grade in the same system; but the eighth-grade score is 66⅔ per cent higher than that of the seventh grade. The same system in Set H makes a score of 4.5 in the fifth grade, 5 in the sixth grade, 1 in the seventh grade, and 5.8 in the eighth grade. In Set I of this system the scores from the fourth to the eighth grade are 0.0, 1.9, 1.9, 4.4. The same variability in rate of progress from grade to grade might be illustrated from every system tested. While the decreased rate of

TABLE VII

Set	Grades				
	4	5	6	7	8
A	13.6–19.9	19.0–24.0	20.0–26.7	19.0–27.6	26.3–32.3
B	7.0–12.9	12.4–19.1	14.4–20.6	16.0–26.7	19.2–24.0
C	5.9–14.3	10.1–17.5	11.0–18.6	13.7–19.5	14.0–19.8
D	5.0–12.5	10.0–17.6	11.0–18.4	15.4–22.3	18.8–21.0
E	3.0– 4.7	3.8– 5.6	4.1– 5.8	3.0– 6.8	5.0– 6.7
F	2.6– 4.7	4.5– 6.7	4.0– 7.6	6.0– 8.8	6.7–10.5
G	2.1– 3.7	2.0– 4.5	3.1– 5.3	4.6– 5.7	5.4– 6.2
H	0.0– 0.0	0.0– 7.1	1.1– 6.0	1.0– 4.8	2.8– 9.0
I	0.0– 1.2	0.0– 1.8	1.3– 4.3	1.9– 4.6	3.1– 4.6
J	1.4– 2.5	2.0– 4.0	2.0– 4.1	2.7– 4.3	4.0– 6.6
K	0.0– 2.6	1.8– 6.5	2.8– 5.0	5.1– 9.3	6.3–17.3
L	0.0– 2.7	1.0– 2.4	1.8– 3.8	2.6– 5.2	3.3– 5.6
M	1.2– 2.5	1.0– 3.3	2.3– 4.6	3.0– 4.8	3.7– 4.8
N	0.5– 0.8	0.0– 0.7	0.0– 2.6	0.0– 1.6	1.0– 2.6
O	0.0– 0.0	0.0– 3.1	1.0– 3.5	2.4– 4.6	2.5– 5.3

progress in some instances may be due to lower mental ability on part of the grade as a whole, undoubtedly many times it is due to poorer teaching or to an unsatisfactory course of study. Supervisors should ascertain whether it is the one or the other cause which makes for poor work.

RELIABILITY OF TESTS AS COMPARED WITH TEACHERS' GRADES FOR THE MONTH IN INDICATING ACCURATELY THE MERIT OF THE INDIVIDUAL PUPIL'S WORK IN ARITHMETIC

A single performance of an individual along any line commonly is not a true indication of his ability in this particular. In order to ascertain how accurately these tests indicated the rank of a pupil in his class the total scores for all tests and from Sets I to O were compiled for the pupils of one school in one of the city systems. The teachers were then requested to furnish the grades of these pupils for the month during which the tests were given. The Pearson method adapted to rank differences was used in determining the correlations. The results were as follows:

Monthly Grade in Arithmetic with Total Score from Tests I to O

Grade 8	0.55
" 7	0.64
" 6	0.58
" 5	0.47

When the total scores from all the tests (A to O) were used in computing the correlation, coefficients were found to be somewhat less than the foregoing, with a single exception.

The correlation was shown in another way. Pupils were grouped, first, upon the basis of the teacher's monthly grade in arithmetic: pupils ranking between 91 per cent and 95 per cent were called Group I, those ranking between 86 per cent and 90 per cent were called Group II, etc. They were then grouped upon the basis of their total scores in Tests I to O inclusive: those ranking between 43 and 48 points were included in Group I, those ranking between 37 and 42 points constituted Group II, etc. Table VIII shows the relations of these groups. It should be read as follows: In Grade 8, 25.9 per cent of those who ranked in Groups I, II, III, etc., according to their teacher's marks also ranked in Groups I, II, III, etc., upon the basis of points made in Tests I to O inclusive; 37.1 per cent of those who ranked in Groups I, II, III, etc., in the first series ranked in Groups II, III, IV, etc., or vice versa; there was a difference of one step in the two ratings.

TABLE VIII

GRADE 8

25.9 per cent of the two rankings agreed
37.1 " " " " were 1 step apart
22.6 " " " " " 2 steps "
11.1 " " " " " 3 " "
3.3 " " " " " 4 " "

GRADE 7

21.4 per cent of the two rankings agreed
51.8 " " " " were 1 step apart
17.9 " " " " " 2 steps "
5.4 " " " " " 3 " "
3.5 " " " " " 4 " "

CONCLUSIONS

1. The score attained by the two groups of schools is less satisfactory than that of the Cleveland schools. The rural schools in 35 out of 60 instances have done this formal work slightly more satisfactorily than the city and village schools taken as a group, although there are individual schools in the latter group that excel the rural-school median in many instances.

2. While the rate of progress from grade to grade as indicated by the total scores in Table I is quite consistent, this is not the case when individual school systems are considered. In fact, in case of the latter this is both uncertain and unsatisfactory. Either the course of study, poor teaching, or the weakness of a certain grade may account for this difficulty.

3. Courses of study should make definite provision for the reviewing of essentials from grade to grade. This should not be left to the discretion of the teacher.

4. Supervisors of teaching must see to it that drills are provided in each grade which will reach *all* the children. The large number of children making a very low score would indicate that present methods of procedure are not reaching them.